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BREEDING STRATEGY IN SMALL AND CLOSED LIVESTOCK POPULATIONS**

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Abstract: This paper reviews the main characteristics of small and/or closed livestock populations. Although the emphasis during the realization of the genetic improvement in animal breeding is put on commercial breeding programmes, autochthonous breeds, races, strains, even herds of domestic animas, at the same time represent a potentially important segment for achieving the maintenance of the overall livestock production. These programmes are particularly important for the improvement of populations of animal genetic resources, as well as for the improvement of production in rural marginal areas. One of the main parameters for determining the size, and also the potential danger of a population is a so called effective size of the population (Ne). This parameter is determined according to the available number of male and female head of breeding stock in the population or in the herd and it varies under the influence of the sexes, changes in the size of the families, changes in the size of the population during time, as well as overlapping of the generations. Apart from the improvement of the economically important traits, the breeding programmes in small populations first of all must provide the increase of the effective size of the population aiming to limit or decrease the inbreeding, as well as the decrease of the variance in the size of the family. This is mainly achieved with so called "circular breeding plans" the sires being replaced by sons in the reproduction, and dams by daughters. The shortage of the generation interval by the change of the presence of some age categories i.e. larger number of young animals and animals that are at the peak of production comparing to a small number of older animals, can additionally influence on the genetic improvement of the traits.

Key words: Breeding programmes, small population, animal genetic resources

Introduction

As in any other production, the profit is achieved in livestock production on the basis of deposited and earned means. What differs animal productions from other productions is the fact that for achieving the overall profitability it is important to take into account numerous biological assumptions and regulations and coordinate them with the principles of the economic operations *(Bogdanović et al.,* 2004, 2005a*)*.

In order to make a livestock production more successful it is necessary to clearly define the breeding goal, as well as the way of its realization. The properly defined breeding goal is of prime importance, because it determines directly the way of the development of the breeding programme that, though, also influence on the achievement of the set goal. The improvement of the traits which are not of importance for the realization of the set goal can potentially have a larger negative effect, than not setting the goal at all *(Bogdanović et al.,* 2005b, 2005c*)*.

In order to achieve one, previously defined, breeding goal it is necessary to define a proper breeding strategy with all necessary elements (for example selection criteria, breeding structure, mating plan, economic analysis, etc). Although, certain difficulties can appear during defining and realizing the breeding goals and programmes in small and/or closed populations of domestic and bred animals *(Bogdanović et al.*, 2007, 2006*)*.

From the aspect of livestock production, small and closed populations are connected mainly with those breeds and/or races of domestic animals which are endangered by genetic violation of the population structure due to a small population number *(Bogdanović et al.,* 2007*)*. In our country in small, and often closed populations there are certain strains of sheep (vlashka zackel, krivovir zackel or lipa zackel), autochthonous cattle breeds (buša or podolian), pigs (moravka or mangulitza), horse (domestic mountain horse) and poultry, as well as domestic buffalo and ass. Though, small populations in animal breeding can be found even when on one farm a special breed or stock is often bred or when the production is aimed in a certain, very specific way (for example the production of milk of a specific protein structure).

On the other side, the genetic improvement of small population of autochthonous breeds, races and strains of domestic animals directly influences on the development of the maintenance of the production and help the improvement of the life of marginal rural areas *(Montironi et al.,* 2006*, Serradilla and Ugarte,* 2006*)*. The goal of this research paper is to analyze

the possibilities for the breeding and selection work in small and closed populations of domestic animals, and first of all in the populations of autochthonous breeds, races and strains.

The characteristics of small populations and the causes of losing the genetic diversity

One of the main parameters for determining the size, and also the potential danger of a population is a so called effective size of the population (Ne). This parameter is determined according to the available number of male and female head of breeding stock in the population and is calculated with the formula [Ne = 4mf / (m+f), where "m" and "f" stand for the number of male and female]. Besides, the effective size of the population is under the influence of the sexes, changes in the size of the families, changes in the size of the population during time, as well as overlapping of the generations

Based on the experiments done over the years, FAO has suggested *(FAO,* 1998*)* the low level of the effective size of the population of 50 if it is desirable to avoid the increase of the coefficient of kin of 1% per year, which would lead to an irretrievable loss of the genetic variability. The effective size of the population of 50 is possible to achieve with, for example, 20 male and 35 female or 15 male and 80 female. This is important due to the reason that even with small populations, if it is possible, a strong selection is performed in even smaller and elite herd, in order to spread the heritage base through the other part of the population using certain selection-breeding actions.

The effective size of the population is an indicator of possible increase of the coefficient of kin, size of the accidental changes of the frequency of genes (so called genetic drift) and the decrease of variations within one breed, race or stock. The most frequent mechanism used for losing heterozygosity in a small population is directly linked with inbreeding or mating in kin. This kind of mating changes the genotype frequency, but the frequency of genes is not changed. To say it differently, the inbreeding increases the homozygosity in relation to heterozygosity which causes two direct effects which are particularly visible in small and closed populations. These are expression of recessive allele and loosing heterozygosity of alleles.

For the preservation of one breed, race or strain it is of main importance to maintain the heterozygosity that is the genetic variability. As long as the

heterozygosity is present in the population, it is possible to perform the selection in a pure race of stock.

The breeding programmes in small and/or closed livestock populations

Theoretically observed, the breeding goal represents the aimed genetic improvement of certain traits realised in successive generations of animals which accomplish the desired production within the future, but expected economic, social and agro-ecological production conditions. The breeding programmes and the genetic improvement of domestic animals is mainly connected with large populations, so that owning small populations equals with maintenance of the present genetic profile, although the genetic improvement of such populations undoubtedly contributes the improvement of the maintenance of the production *(Montironi et al.,* 2006*, Serradilla and Ugarte,* 2006*)*. Although at first glance it seems that defining of the breeding goals in the populations of different sizes has the same components, the realization of a breeding goal depends greatly on the size of population.

As in the commercial breeding programmes, the aim of the selection within one closed population is the increase of the average level of the genetic value for a certain traits. This can be achieved if the selection or a breeding programme is performed through several phases. Beside the improvement of the economically important traits, the breeding programmes in the small populations first of all must provide the increase of the effective size of the population with the aim to limit and decrease inbreeding, as well as the decrease of the variance in the size of the family. This is mainly achieved with the so called “circular breeding plans”. This breeding scheme starts from the equal number of base animals (male and female) which are not kin related, and in each herd replacement the sire is being replaced with one of the sons, and dam with one of the daughters.

By maintaining or increasing the effective size of the population it is possible to perform the selection of the economic important traits. Having in mind that the selection pressure on the small populations of the autochthonous domestic animals has not been extremely expressed, it is real to expect that the present traits variability provides a relatively good base for aiming the populations in the desired way. In addition, the shortage of the generation interval by the change of the presence of certain age categories in the sense of presence of younger animals and the animals that are the

production peak, comparing the older animal, can additionally impact on the genetic improvement of the traits.

On the other side, when the population gets near or reaches the selection limits, either it was caused by the decrease of the effective size or performing the strong selection, it is necessary to intervene in the sense of migration of genes among different herd within a certain population, or, even, among different races. But, the migration of genes between races can cause in great sense the loss of a certain part of the characteristic genetic variability, so crossbreeding should be avoid within the populations of autochthonous breeds, races and strains of domestic animals. If it is, still, necessary to perform the crossbreeding, it is desirable to choose the most similar races so that the genetic identity of the race which is being refreshed or improved can be saved as much as possible.

Important problematical factors which often effect on the realization of the breeding programmes in small and/or closed populations of domestic animals are the lack of the necessary infrastructure for performing the control of the productivity, nucleus herds (if there are any) are very small parts of the whole population, the lack of reliable pedigree information, as well as the difficult assessment of the genetic value of the breeding animals.

In addition, it is necessary to have in mind that one of the characteristics of the autochthonous breeds, races and strains of domestic animals is their excellent adaptability to the local zootechnical and ecological conditions, but at the same time the small productivity. By the improvement of the feed conditions, the husbandry and care and at the same time, by performing the strong selection of the parental couples it is possible to improve certain traits, first of all those which reflect in average or high coefficients of heritability such as the traits of milk production, beef and growth traits or carcass traits.

ODGAJIVAČKA STRATEGIJA U MALIM I ZATVORENIM POPULACIJMA DOMAĆIH ŽIVOTINJA

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Rezime

U radu su prikazane osnovne karakteristike malih i/ili zatvorenih

populacija domaćih i gajenih životinja. Iako se akcenat prilikom realizacije genetskog unapređenja u stočarstvu stavlja na komercijalne odgajivačke programe, autohtone vrste, rase, sojevi, pa i zapati domaćih životinja, takođe predstavljaju potencijalno važan segment za dostizanje održivosti celokupne stočarske proizvodnje. Ovi programi su naročito značajani za unapređenje populacija animalnih genetskih resursa, kao i za unapređenje proizvodnje u ruralnim marginalnim oblastima. Jedan od osnovnih parametara za određivanje veličine, pa samim tim i potencijalne ugroženosti jedne populacije jeste tzv. efektivna veličina populacije (Ne). Ovaj parametar se određuje na osnovu raspoloživog broja priplodnjaka i plotkinja u populaciji ili zapatu i varira pod uticajem odnosa polova, promena u veličini familija, promena u veličini populacije tokom vremena, kao i preklapanja generacija. Pored unapređenja ekonomski važnih osobina, odgajivački programi u malim populacijama na prvom mestu moraju obezbediti povećanje efektivne veličine populacije sa ciljem ograničavanja ili smanjivanja *inbreeding*-a, kao i smanjivanja varijanse u veličini familije. To se uglavnom postiže tzv. „cirkularnim odgajivačkim planovima“ u kojima očeve u reprodukciji zamenjuju sinovi, a majke kćeri. Skraćenje generacijskog intervala promenom zastupljenosti pojedinih starosnih kategorija u smislu veće zastupljenosti mladih grla i grla koja su u vrhu proizvodnje, a na račun starijih grla, može dodatno uticati na genetsko unapređenje osobina.

Ključne reči: Odgajivački programi, male populacije, animalni genetički resursi.

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